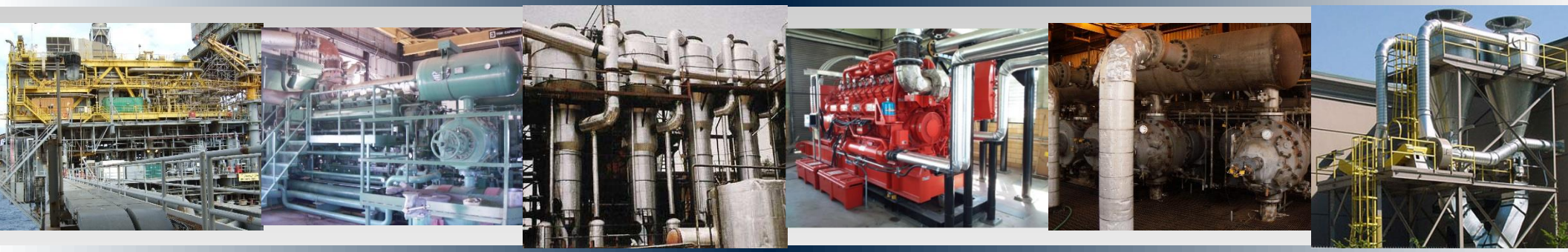


Designing your Substations for Grid Resiliency

Mesa Associates, Inc.

Engineers and Consultants

SRMSDC

Women's Business Enterprise National Council WBENC

What is Resiliency?

"The resilience of the distribution system is based on three elements: prevention, recovery, and survivability. Damage prevention refers to the application of engineering designs and advanced technologies that harden the distribution system to limit damage. System recovery refers to the use of tools and techniques to quickly restore service to as many affected customers as practical. Survivability refers to the use of innovative technologies to aid consumers, communities, and institutions in continuing some level of normal function without complete access to the grid."

-EPRI

"Infrastructure resilience is the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event."

-CRITICAL INFRASTRUCTURE RESILIENCE FINAL REPORT AND RECOMMENDATIONS, NATIONAL INFRASTRUCTURE ADVISORY COUNCIL, 2009

"The ability to resist failure and rapidly recover from breakdown."

-The Smart Grid Dictionary

"the power or ability to return to the original form, position, etc., after being bent, compressed, or stretched; elasticity", or

"ability to recover readily from illness, depression, adversity, or the like; buoyancy"

-Webster's Dictionary

What is Reliability?

"Reliability can be defined as the ability of the power system to deliver electricity in the quantity and with the quality demanded by users. Reliability is generally measured by interruption indices defined by the Institute of Electrical and Electronics Engineers Standard 1366."

-Industrial Control Systems –Cybersecurity Emergency Response Team (IC-CERT)

"*Reliable Operation* means operating the elements of the Bulk-Power System within equipment and electric system thermal, voltage, and stability limits so that instability, uncontrolled separation, or cascading failures of such system will not occur as a result of a sudden disturbance, including a Cybersecurity Incident, or unanticipated failure of system elements."

-FERC, 18 CFR 39.1

"Reliability is a measure of behavior once resilience has broken."

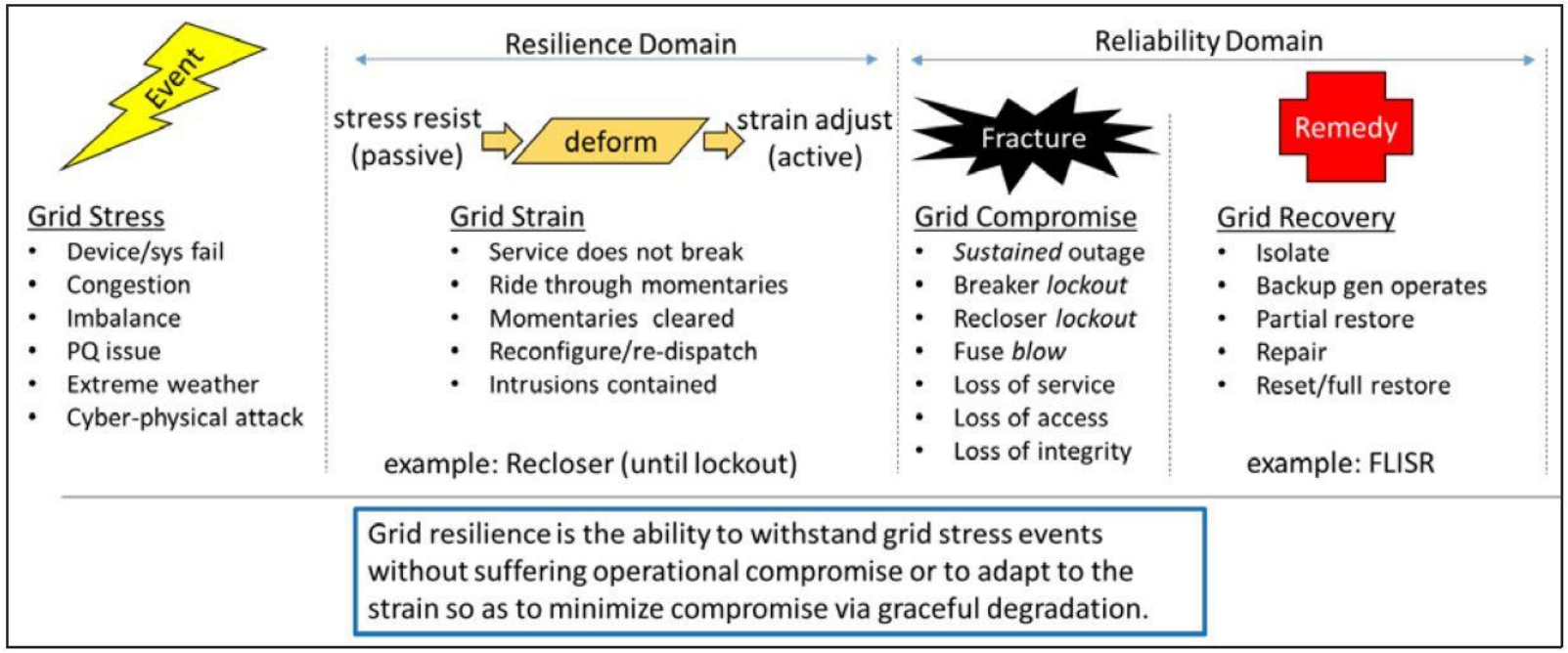
- Dr. JD Taft, Pacific Northwest National Laboratory

"the ability to be relied on or depended on, as for accuracy, honesty, or achievement"

-Webster's Dictionary

Similarities & Differences

- **Reliability can be measured and defined through metrics (SAIDI, SAIFI, CAIDI)**
- **Resilience is a characteristic of a system, not a measurement**
- **Ability to recover quickly and efficiently is often used to define both reliability and resilience.**



Substation v/s Overhead Resilience

- **Difficult, often times, to separate substation resilience from overhead resilience**
- **Solutions are often compatible and complimentary between substations and overhead**
- **Overhead resilience usually begins at the substation when the line(s) become distribution circuits**
- **Characteristics or measures used to increase resilience in one area assist with another and can also increase reliability**

Threats to Resiliency

- **T&D System stress & strain**
  - Power quality issues
  - Equipment failure
  - Criminal activity
- **Customer Demand**
  - Peaking operations
  - Rapid user growth
- **Environment**
  - Weather/climate
  - Physical surroundings
- **People**
  - Cyber attacks
  - Intruders

Increasing Resilience…Smart

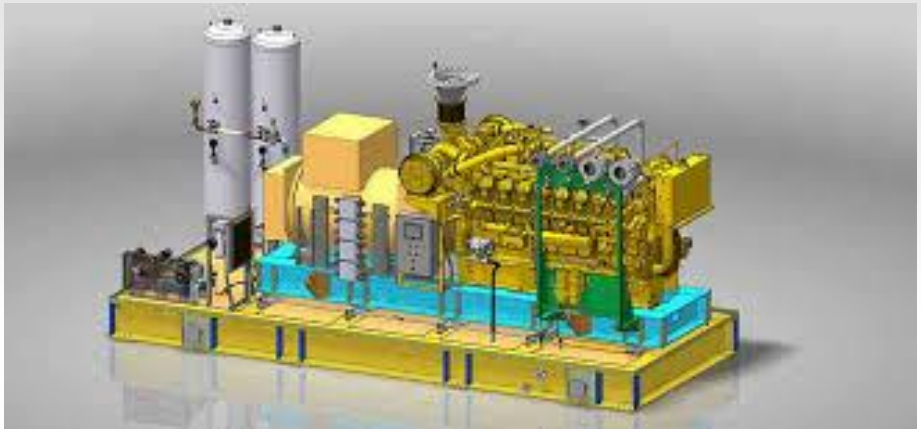
- **Smart Systems**
  - Intelligent equipment
    - Embedded technology such as smart switches, voltage regulators, and reclosers
    - Coordinated relay protection schemes
  - Real-time or near real-time monitoring
    - Know what is happening and when
    - Be able to react to changing conditions and system operations remotely
  - Asset health & PM programs
    - Utilize predictability systems (such as Exacter) to repair before failure
    - Don’t operate until it’s broken
    - Preventative Maintenance programs such as Mapcon, Fiix, UpKeep, and Maximo can be“inexpensive” solutions

Increasing Resilience…Harden

- **Hardening installations**
  - Momentary ride-through
    - Highly coordinated relay protection schemes
    - Equipment sized to handle excursions
  - Clearing momentary upsets
    - Utilizing reclosers
  - Intrusions contained
    - Active monitoring and rapid response to intrusions
    - Hard as well as soft
  - Physical Barriers
    - Literally physical barriers such as concrete walls, elevation, and razor wire fences
    - Up-to-date computer hardware including firewalls, routers, etc.

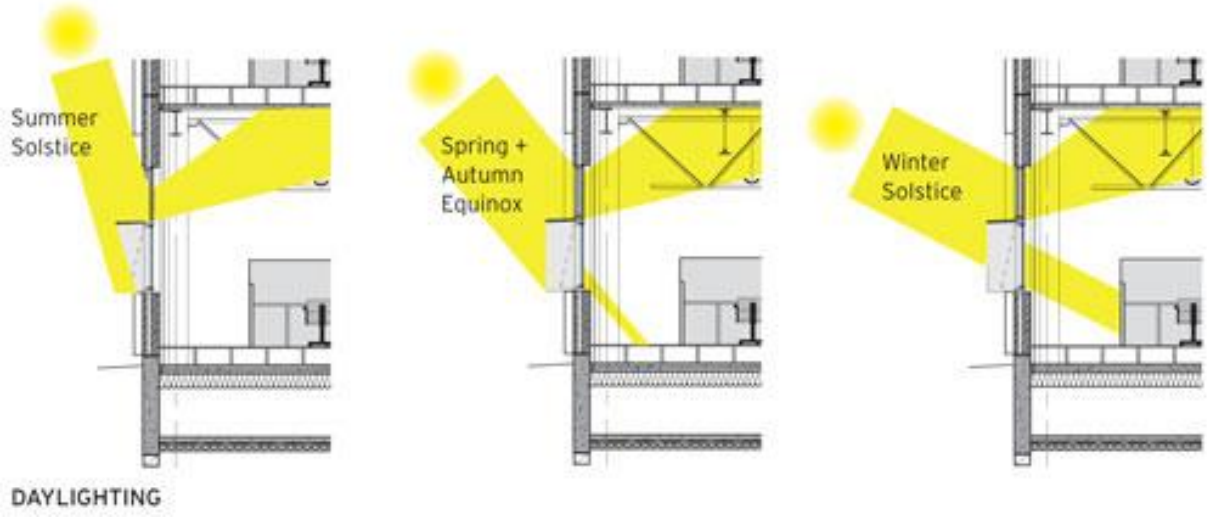
Increasing Resilience…Distribute

- **Distributed Generation/Storage**
  - Natural Gas/Diesel Generators
    - Peak shaving and demand response
    - Emergency or backup capabilities
  - Wind, Solar, & Batteries
    - Parallel to the grid
    - "Behind the meter"
  - Shared Utilities
    - Combined Heat & Power – shared power & steam/hot water needs
  - Customer Load Shedding
    - Pre-arranged agreements with larger customers
    - Similar to demand response

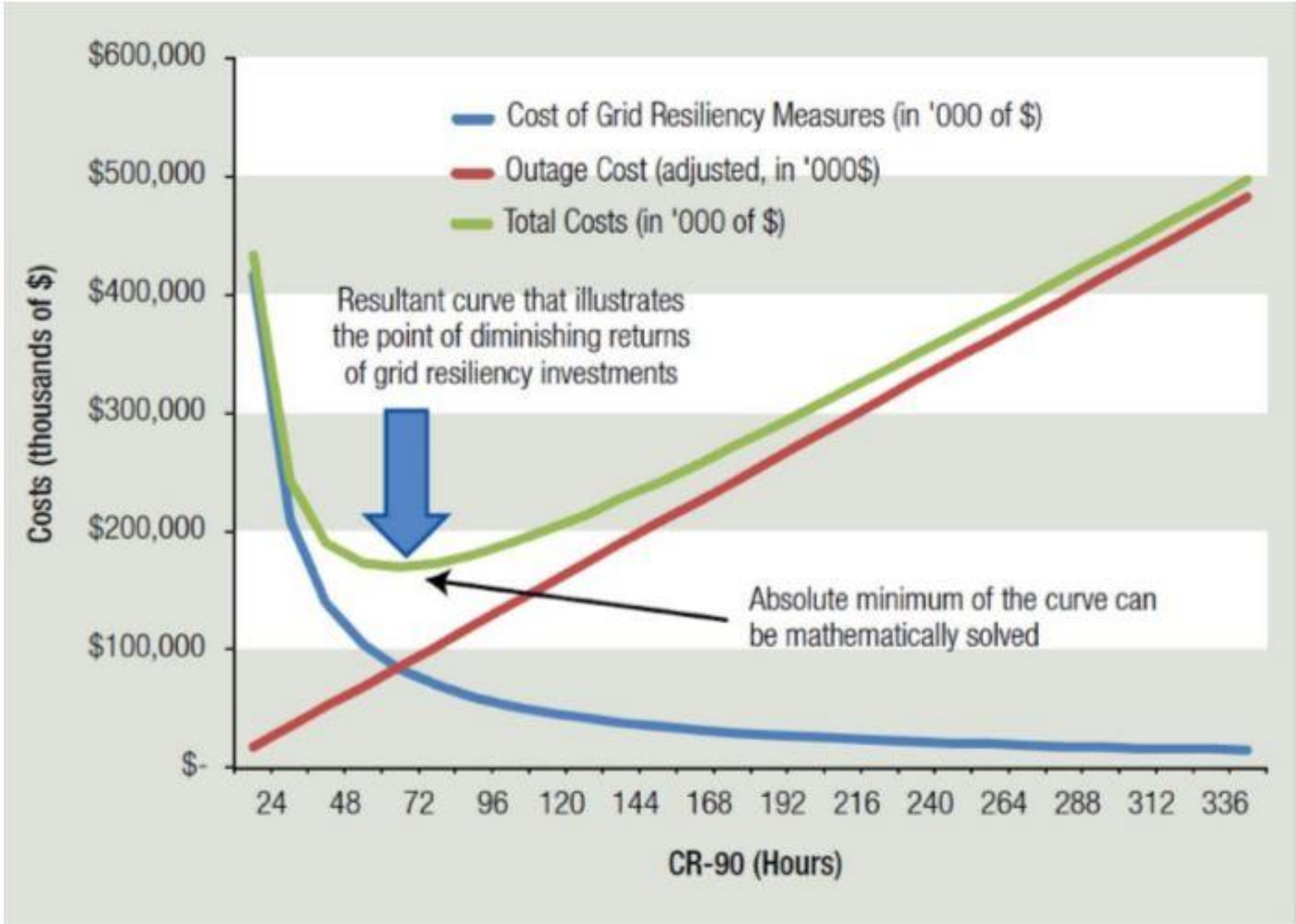


Increasing Resilience…Customer

- **Customer resilience**
  - Building for resilience
    - LEED principals
    - Day-lighting
    - Landscaping (shade, protection, etc.)
  - Energy efficiency programs
    - Programmable thermostats
    - LED, CFL lighting
    - Less need, less strain



Resiliency: Cost versus Benefit



"The 4 Main Pillars of Enhancing Utility Grid Resilience"

Philip Mihlmester & Anne Choate

Greentech Media (October 13, 2017)

Questions?

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